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**Title:** Prevalence in Primary School Youth of Pica and Rumination Behavior: The Understudied Feeding Disorders

**Running Title:** PREVALENCE OF PICA AND RUMINATION

Helen B. Murray, B.A.[1]

Jennifer J. Thomas, Ph.D.[2,3]

Andreas Hinz, Ph.D.[4]

Simone Munsch, Ph.D.[5]

Anja Hilbert, Ph.D.[6]

[1]Department of Psychology, Drexel University, Philadelphia, PA, USA
[2]Eating Disorders Clinical and Research Program, Massachusetts General Hospital, Boston, MA, USA
[3]Department of Psychiatry, Harvard Medical School, MA, USA
[4]Department of Medical Psychology and Medical Sociology, University of Leipzig Medical Center, Leipzig, Germany
[5]Department of Psychology, University of Fribourg, Fribourg, Switzerland
[6]Integrated Research and Treatment Center Adiposity Diseases, Departments of Medical Psychology and Medical Sociology and Psychosomatic Medicine and Psychotherapy, University of Leipzig Medical Center, Leipzig, Germany

**Correspondence:** Helen B. Murray, B.A., Department of Psychology, Drexel University, 3141 Chestnut Street, Stratton 226, Philadelphia, PA 19104; Telephone: 216-895-1653; E-mail: hb397@drexel.edu.

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**Abstract**

**Objective:** Little epidemiological evidence exists on rumination disorder behavior (RB) and pica behavior (PB). We examined prevalence of RB and PB and presence of comorbid feeding/eating disorder symptoms among school-aged children. **Methods:** In elementary schools in Switzerland, 1,430 children (54.0% female) ages seven to 13 completed Eating Disorder Examination-Questionnaire for children (ChEDE-Q) and Eating Disturbances in Youth Questionnaire (EDY-Q). **Results:** EDY-Q data behavior frequency showed 9.7% reported RB only, 10.0% reported PB only, and 3.1% reported RB+PB (≥1 on 0-6 Likert scale). At a clinical cut-off score of ≥4 (at least "often true"), 1.7% had RB only, 3.8% had PB only, and 1.1% had RB+PB. Avoidant/restrictive food intake disorder symptoms were most common in those with RB+PB, and more common in those with RB or PB than those without. Degree of eating disorder symptoms (by ChEDE-Q) over the past 28 days were similar among those with RB, PB, or RB+PB, but less common in those without RB or PB. **Discussion:** RB and PB were commonly reported in our sample of school-aged children, even at a potential clinically significant cut-off. Our findings also suggest that degree of eating disorder symptom comorbidity is similar between those with RB and PB.

**Key Words**: rumination disorder, rumination syndrome, pica, feeding disorder, prevalence, avoidant/restrictive food intake disorder, ARFID

## Introduction

Rumination disorder and pica were recently re-classified as "Feeding and Eating Disorders" in *DSM-5*, due in part to the realization that they can occur across the age-span (APA, 2013). Rumination involves repeated, effortless regurgitation of recently ingested food with subsequent re-chewing, re-swallowing, and/or spitting out of the regurgitated material (APA, 2013; Drossman et al., 2016). Rumination is also classified as a functional gastrointestinal disorder by the ROME Foundation (Drossman et al., 2016). Pica involves recurrent consumption of non-nutritive, non-food substances (e.g., sand, paper) not in the context of a culturally normative practice or another mental or physical condition (APA, 2013). Many individuals with rumination or pica have a protracted illness course (e.g., 15 years; Thomas and Murray, 2016). Without treatment, significant health and psychosocial consequences can ensue, such as dental enamel erosion and avoidance of social eating in rumination, and gastrointestinal obstruction in pica (APA, 2013). More research is needed on prevalence and presentation of rumination and pica to improve detection and differential diagnosis.

General population prevalence data on rumination behavior (RB) and pica behavior (PB) are limited and inconclusive. Two studies with adult community samples found drastically different prevalence of RB based on self-reported *ROME* criteria (0.8% of 1,149 Canadian adults; Thompson, Irvine, Pare, Ferrazzi, and Rance, 2002, versus 10.6% of 5,430 U.S. adults; Drossman et al., 1993). Only two prevalence studies exist on self-reported RB in youth (5.1% of 2,163 Sri Lankan children ages 10-16 by *ROME* criteria; Rajindrajith, Devanarayana, and Perera, 2012, and 1.5% of 804 German children ages 7-14; Hartmann et al., 2018). Few prevalence studies exist in youth on general PB not specific to geophagy (1.7% of 659 U.S. children ages 1-10; Marchi and Cohen, 1990, and 5.0% of 804 German children ages 7-14; Delaney et al., 2015).

For both RB and PB, there is no research on the frequency or severity of symptoms that inform diagnosis; by *DSM-5*, rumination disorder regurgitations must occur at least weekly and pica eating must be "persistent" (APA, 2013). More epidemiological research is needed to improve our understanding of the frequency of RB and PB and their illness burden.

Understanding degree of overlap with other feeding/eating disorders could also improve detection and inform differential diagnosis. *DSM-5* trumping rules forbid comorbid diagnosis of rumination (but not pica) with another feeding/eating disorder (APA, 2013). However, several case reports and studies with clinical samples have shown overlap between eating disorders and RB or PB (e.g., 7.4% and 1.3%, respectively, of 149 residential patients; Delaney et al., 2015). Some individuals with RB or PB use the behavior to control their shape/weight (e.g. Thomas and Murray, 2016), have secondary food restriction and/or weight loss (APA, 2013), or endorse current or past self-induced vomiting (Delaney et al., 2015; Eckern, Stevens, & Mitchell, 1999). One study identified comorbid RB (12%) and PB (12%) among youth with avoidant/restrictive food intake disorder (ARFID) symptoms (Hartmann et al., 2018). RB and PB appear to co-occur with other feeding/eating disorders, but more research is needed on (1) whether feeding/eating disorder symptoms are more common in those with or without RB or PB and (2) if RB and PB have differential overlap with other feeding/eating disorders.

In children ages 7-13, the current study examined prevalence of RB and PB (Aim 1) and presence of comorbid feeding/eating disorder symptoms by self-report (Aim 2). For Aim 2 we hypothesized compared to those without RB or PB, those with RB and/or PB would have greater likelihood of also having ARFID symptoms (Hypothesis 1) and eating disorder symptoms (Hypothesis 2). We also hypothesized among those reporting RB, PB, or RB+PB there would be

no significant difference in frequency of ARFID symptoms (Hypothesis 3) or eating disorder symptoms (Hypothesis 4).

## Methods

### Procedures

This study was part of the Swiss University Study of Nutrition (SUN), approved by Ethics Committees of the Canton of Fribourg and University of Fribourg's Department of Psychology. SUN recruited 1,452 children between ages 7-13 from 3rd-6th grade schools in metropolitan areas of Fribourg, Lausanne, and Bern in Switzerland. We obtained parental consent and participant assent. Participants completed Eating Disturbances in Youth-Questionnaire (EDY-Q; Kurz, Van Dyck, Dremmel, Munsch, and Hilbert, 2015, 2016), Eating Disorder Examination-Questionnaire adapted for children (ChEDE-Q; TODAY Study Group, 2007), and self-report demographics including height/weight. We excluded 23 participants who either completed less than 40% of EDY-Q or did not complete RB or PB items, resulting in 1,430 children (54.0% female), who were on average 10.5 (SD=1.3) years old. Participants completed German (*n*=670) or French (*n*=760) questionnaire versions.

### Measures

EDY-Q (14-items) measures ARFID symptoms, RB, and PB on 7-point Likert scale (never true=0; always true=6). EDY-Q captures how generally true RB and PB behaviors are for participants by a question on regurgitation of swallowed food and by a question on consumption of things not meant for eating (e.g., sand), respectively. We defined presence of any RB and PB with scores ≥1 and a conservative clinical cut-off score ≥4. We determined clinical cut-off based on prior eating behavior research with a score ≥4 to indicate potential clinical significance, such as ARFID symptoms by EDY-Q (Kurz et al., 2015) and EDE-Q cut-off (Carter, Stewart, &

Fairburn, 2001). We classified cases with ARFID symptoms with items covering DSM-5 diagnostic criteria (see Kurz et al., 2015). EDY-Q has shown adequate discriminant and convergent validity for ARFID symptoms in this sample (Kurz et al., 2015).

We used nine items of the ChEDE-Q (TODAY Study Group, 2007) to assess eating disorder cognitions (fear of weight gain; dissatisfaction with shape/weight) and behaviors (restraint over eating, binge eating, vomiting, laxative/diuretic use). Overall, ChEDE-Q has good discriminant validity, convergent validity, and internal consistency ($\alpha$=0.94; Hilbert, Hartmann, and Czaja, 2008).

**Statistical Analysis**

For Aim 1, we calculated frequencies and confidence intervals for participants who reported RB, PB, or RB+PB (scores ≥1) and at the clinical cut-off (scores ≥4). For Aim 2, we compared ARFID symptom frequency (Hypothesis 1) and eating disorder cognitions and behaviors (Hypothesis 2) between those with (scores ≥4) and without RB or PB (scores=0). For Hypothesis 2, we excluded *n*=108 participants who met our criteria for ARFID symptoms so that the group without PB or RB was asymptomatic of potentially clinically significant feeding disorder symptoms. Among those with RB and/or PB at the clinical cut-off of ≥4 (RB only, PB only, and RB+PB groups), we compared frequency of ARFID symptom presence (Hypothesis 3) and eating disorder cognitions and behaviors (Hypothesis 4). We conducted Kruskal-Wallis *H* tests for continuous variables and $\chi^2$ tests for categorical variables. We used Kruskal-Wallis *H* tests for ChEDE-Q variables because they all showed significantly left skewed distributions. ChEDE-Q variables included eating disorder cognitions and behaviors (fear of weight gain; dissatisfaction with shape/weight) or behaviors (restraint over eating, binge eating, vomiting, laxative/diuretic use). For family-wise area among variables included in Aim 2 (14 comparisons),

we applied a conservative Bonferroni correction with an $\alpha<.004$). Missing data were low with 0–1.0% per item in the total sample.

## Results

Table 1 displays frequency distribution of RB and PB endorsement. Kolmogorov–Smirnov tests showed a significantly left skewed distribution (*p*'s<.001), indicating RB and PB were relatively rare. In total, 139 (9.7%; 95%CI=8.2-11.4%) reported RB only, 143 (10.0%; 95%CI=8.5-11.7%) reported PB only, and 45 (3.1%; 95%CI=2.3-4.2%) reported RB+PB. At the clinical cut-off score ≥4, 24 (1.7%; 95%CI=1.1-2.5%) had RB only, 55 (3.9%; 95%CI=2.9-4.9%) had PB only, and 16 had RB+PB (1.1%; 95%CI=0.6-1.8%). There were no significant differences in age, sex, standardized BMI (SDS), or BMI percentile category among groups (no RB/PB, RB only, PB only, and RB+PB).

Table 2 displays ARFID symptoms by EDY-Q and eating disorder symptoms by ChEDE-Q within RB and PB groups. Consistent with Hypotheses 1 and 2, in those with either RB or PB (scores ≥4) compared to those without either RB or PB (scores=0), we found a significantly higher frequency of ARFID symptoms [$\chi^2(1,N=1179)=15.2$, $p<.001$; 16.3% vs. 5.8%; $OR=3.2$] and all eating disorder cognition and behavior variables [$H(1)=9.6\text{-}21.3$, *p*'s=.0001-.002]. Findings held true for any RB or PB (scores ≥1). For Hypothesis 3, we hypothesized ARFID symptom frequency would not be significantly different among groups (RB, PB, or RB+PB). We found a higher, but non-significant, frequency of ARFID symptoms by EDY-Q in participants who reported scores ≥4 for RB+PB compared to RB only or PB only [$\chi^2(2, N=95)=13.8$, p>.004]. Consistent with Hypothesis 4, we found no significant difference in level of comorbid eating disorder cognitions or behaviors among those who reported scores ≥4 for RB only, PB

only, or RB+PB [$H(2)=0.1\text{-}3.3$, $p$'s=ns]; these results held constant when we compared individuals with and without ARFID symptoms, RB, or PB.

## Discussion

The current study is the first to report RB and PB prevalence data from a school-based sample representative of several regions in Switzerland. We found RB and PB prevalence similar to previous reports on RB and on other feeding and eating disorder symptoms. Our threshold of ≥4 for potential clinical significance resulted in 1.7% with RB only, 3.9% with PB only, and 1.1% with RB+PB. Thus, 2.8% had RB, which is in between RB prevalence confidence intervals previously found in youth, including by *ROME* criteria (5.1% of 2163; 95%CI=4.2-6.1%; Rajindrajith et al., 2012) and by EDY-Q (1.5% of 804; 95%CI=0.8-2.6%; Hartmann et al., 2018). Our finding of 5.0% PB prevalence replicates previous research showing 5.0% prevalence based on EDY-Q in similarly-aged youth (Hartmann et al., 2018).

We found those with RB or PB (scores ≥4) more commonly had ARFID symptoms than those without RB or PB. This finding supports that those with RB or PB had greater feeding disorder symptomatology than those without RB or PB. Overall comorbidity with ARFID symptoms among those with RB and/or PB was similar. Further research is needed to confirm these findings via clinical interview.

Although we were not able to determine presence of full-threshold eating disorders, we found comorbidity with pathological eating behavior (e.g., binge eating, compensatory behaviors). Compared to participants without RB, PB, or ARFID, participants with RB or PB had greater levels of fear of weight gain, dissatisfaction with shape/weight, and restraint over eating. They also had more frequent binge eating, vomiting, and laxative/diuretic use. Among participants with RB, PB or RB+PB, degrees of eating disorder cognitions and behavior were

similar. These findings should be interpreted with caution, since eating disorder cognition symptoms—though higher than in healthy youth—were still at sub-clinical levels, even among those with RB and PB (mean scores 1.6 to 2.9 for fear of weight gain and dissatisfaction with weight/shape).

Our findings suggest RB and PB both are similarly associated with ARFID and other eating disorder symptoms, which extends previous correlational findings using EDY-Q (Hartmann et al., 2018). Some individuals with RB or PB may have comorbid eating disorder symptomatology (Delaney et al., 2015). Allowing comorbid diagnosis of rumination disorder with other feeding/eating disorders could be instrumental for a patient to receive appropriate treatment (e.g., strategies from CBT for Rumination Disorder; Thomas and Murray, 2016). To inform future *DSM* revisions on comorbid diagnosis of rumination disorder with other feeding/eating disorders, future research should examine samples meeting diagnostic criteria for rumination disorder.

Some limitations exist. First, although children of similar age to our sample have been able to self-report symptoms accurately (Riley, 2004), over- or under-estimation of symptoms is possible (including height/weight). Second, the EDY-Q only includes individual items for each RB and PB that have not been validated against clinical interview. For example, some participants may have interpreted the RB item to mean vomiting. Third, we did not measure relations of RB and PB with general psychopathology; future research should examine these relations to extend recent findings of low associations between RB/PB and general psychopathology (Hartmann et al., 2018).

Our findings add to prevalence literature on RB and PB as well as data on symptom overlap to support comorbid diagnosis with other feeding/eating disorders. Future research is

needed to validate self-report surveys for RB and PB and determine general population prevalence and course across the age-spectrum and from international samples.

## References

APA. (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* (fifth ed.): American Psychiatric Publishing, Arlington, VA.

Carter, J. C., Stewart, D. A., & Fairburn, C. G. (2001). Eating disorder examination questionnaire: norms for young adolescent girls. *Behaviour Research and Therapy, 39*(5), 625-632.

Delaney, C. B., Eddy, K. T., Hartmann, A. S., Becker, A. E., Murray, H. B., & Thomas, J. J. (2015). Pica and rumination behavior among individuals seeking treatment for eating disorders or obesity. *International Journal of Eating Disorders, 48*(2), 238-248. doi:10.1002/eat.22279

Drossman, D., Chang, L., Chey, W. D., Kellow, J., Tack, J., Whitehead, W. E., & Committees, R. I. (Eds.). (2016). *ROME IV: Functional Gastrointestinal Disorders – Disorders of Gut-Brain Interaction* (4 ed. Vol. 2). Raleigh, NC: Rome Foundation.

Drossman, D. A., Li, Z., Andruzzi, E., Temple, R. D., Talley, N. J., Grant Thompson, W., . . . Corazziari, E. (1993). US householder survey of functional gastrointestinal disorders. *Digestive Diseases and Sciences, 38*(9), 1569-1580.

Eckern, M., Stevens, W., & Mitchell, J. (1999). The relationship between rumination and eating disorders. *International Journal of Eating Disorders, 26*(4), 414-419.

Group, T. S. (2007). Treatment options for type 2 diabetes in adolescents and youth: a study of the comparative efficacy of metformin alone or in combination with rosiglitazone or lifestyle intervention in adolescents with type 2 diabetes. *Pediatric Diabetes, 8*(2), 74.

Hartmann, A. S., Poulain, T., Vogel, M., Hiemisch, A., Kiess, W., & Hilbert, A. (2018). Prevalence of pica and rumination behaviors in German children aged 7–14 and their

associations with feeding, eating, and general psychopathology: a population-based study. *European Child and Adolescent Psychiatry*, 1-10.

Hilbert, A., Hartmann, A., & Czaja, J. (2008). Child eating disorder examination-questionnaire: Evaluation der deutschsprachigen version des essstörungsfragebogens für kinder. *Klinische Diagnostik und Evaluation, 1*(4), 447-463.

Jugendalter, A. A. i. K.-u. (2001). Leitlinien der Arbeitsgemeinschaft Adipositas im Kindesund Jugendalter [Guidelines of the Workgroup for Adiposity in

Childhood and Adolescence]. Retrieved from http://www.adipositas-gesellschaft.de/fileadmin/PDF/Leitlinien/AGA_S2_Leitlinie.pdf

Kurz, S., Van Dyck, Z., Dremmel, D., Munsch, S., & Hilbert, A. (2015). Early-onset restrictive eating disturbances in primary school boys and girls. *European Child and Adolescent Psychiatry, 24*(7), 779-785.

Kurz, S., van Dyck, Z., Dremmel, D., Munsch, S., & Hilbert, A. (2016). Variants of early-onset restrictive eating disturbances in middle childhood. *International Journal of Eating Disorders, 49*(1), 102-106.

Marchi, M., & Cohen, P. (1990). Early childhood eating behaviors and adolescent eating disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 29*(1), 112-117.

Rajindrajith, S., Devanarayana, N. M., & Perera, B. J. C. (2012). Rumination syndrome in children and adolescents: a school survey assessing prevalence and symptomatology. *BMC Gastroenterology, 12*(1), 163.

Riley, A. W. (2004). Evidence that school-age children can self-report on their health. *Ambulatory Pediatrics, 4*(4), 371-376.

Thomas, J. J., & Murray, H. B. (2016). Cognitive-behavioral treatment of adult rumination behavior in the setting of disordered eating: A single case experimental design. . *International Journal of Eating Disorders, 49*, 967-972.

Thompson, W., Irvine, E., Pare, P., Ferrazzi, S., & Rance, L. (2002). Functional gastrointestinal disorders in Canada: first population-based survey using Rome II criteria with suggestions for improving the questionnaire. *Digestive Diseases and Sciences, 47*(1), 225-235.

Table 1. Item Distribution of Rumination Behavior and Pica Behavior Endorsement (*N*=1430)

| | **RB** | **PB** |
|---|---|---|
| ***M (SE)*** | 0.3 (0.03)† | 0.4 (0.03)‡ |
| **Individual Score Distribution, *N* (%)** | | |
| Score=0 ("Never True") | 1246 (87.1%) | 1242 (86.9%) |
| Score=1 | 96 (6.7%) | 84 (5.9%) |
| Score=2 | 27 (1.9%) | 20 (1.4%) |
| Score=3 | 21 (1.5%) | 14 (1.0%) |
| Score=4 | 10 (0.7%) | 16 (1.1%) |
| Score=5 | 5 (0.3%) | 9 (0.6%) |
| Score=6 ("Always True") | 25 (1.7%) | 45 (3.1%) |

Note. RB=rumination behavior; PB=pica behavior; *M*=mean; *SE*=standard error. EDY-Q captures how generally true RB and PB behaviors are on a Likert scale of 0 (Never True) to 6 (Always True).

†Skewness=4.3; Kurtosis=18.9; Kolmogorov-Smirnov test $p<.001$.

‡Skewness=3.7; Kurtosis=12.8; Kolmogorov-Smirnov test $p<.001$.

Table 2. Demographic and Feeding and Eating Disorder Symptoms in Participants with Rumination and/or Pica Behavior

| | **RB item ≥4 (*n*=24)** | **PB item ≥4 (*n*=55)** | **RB/PB items ≥4 (*n*=16)** | **No RB/PB (*n*=1103)** |
|---|---|---|---|---|
| **Age, *M (SD)*** | 9.7 (1.6) | 10.5 (1.4) | 9.9 (1.6) | 10.6 (1.3) |
| **Sex-female, *N* (%)** | 13 (54.2%) | 28 (50.9%) | 13 (81.3%) | 610 (55.3%) |
| **BMI†** | | | | |
| BMI value- *M (SD)* | 17.5 (3.0) | 17.5 (2.6) | 17.1 (2.9) | 17.4 (2.7) |
| BMI SDS- *M (SD)* | -0.2 (1.4) | -0.1 (1.0) | -0.3 (1.3) | -0.1 (1.1) |
| Percentile category- *N* (%) | | | | |
| *Underweight (<10$^{th}$)* | 3 (20.0%) | 6 (11.8%) | 2 (20.0%) | 147 (14.0%) |
| *Normal Weight (10$^{th}$-90$^{th}$)* | 11 (73.3%) | 41 (80.4%) | 7 (70.0%) | 844 (80.5%) |
| *Overweight (>90-97$^{th}$)* | 1 (6.7%) | 3 (5.8%) | 1 (10.0%) | 42 (4.0%) |
| *Obesity (>97$^{th}$)* | 0 (0.0%) | 1 (2.0%) | 0 (0.0%) | 16 (1.5%) |
| **ARFID** (EDY-Q), ***N* (%)‡** | 5 (20.8%) | 3 (5.6%) | 7 (43.8%) | 63 (5.8%) |
| **ChEDE-Q** § | | | | |

| | | | | |
|---|---|---|---|---|
| Any vomiting, *N* (%) | 7 (29.2%) | 7 (12.7%) | 3 (18.8%) | 62 (5.7%) |
| Any laxative/diuretic, *N* (%) | 5 (20.8%) | 6 (10.9%) | 1 (6.3%) | 36 (3.3%) |
| Any binge-eating, *N* (%) | 16 (66.7%) | 24 (43.6%) | 7 (43.8%) | 341 (30.9%) |
| ≥4 binge-eating episodes past month, *N* (%) | 3 (12.5%) | 6 (10.9%) | 3 (18.8%) | 68 (6.2%) |
| Restraint over eating, *M (SD)* | 1.3 (1.7) | 1.3 (1.8) | 2.2 (2.1) | 0.92 (1.6) |
| Fear of weight gain, *M (SD)* | 2.4 (2.8) | 1.6 (2.0) | 1.8 (2.5) | 1.1 (1.9) |
| Dissatisfaction w/ shape/weight, *M (SD)* | 2.9 (2.3) | 2.0 (1.9) | 2.3 (2.3) | 1.6 (1.8) |

Note. RB=rumination behavior; PB=pica behavior; ARFID=avoidant/restrictive food intake disorder; EDY-Q=Eating Disturbances in Youth Questionnaire (EDY-Q); ChEDE-Q=Eating Disorder Examination-Questionnaire adapted for children; BMI=body mass index; SDS=standard deviation scores calculated by the LMS method.

†Percentages are based on the data available because there were missing BMI data for *n*=18 participants with PB and/or RB and *n*=54 participants with no PB or RB. Percentile ranges based on the guidelines of the Workgroup on Adiposity in Children and Adolescence (Jugendalter, 2001).

‡Percentages are based on the data available because there were missing data on ARFID frequency for *n*=5 participants with PB and/or RB and *n*=16 participants with no PB or RB.

§Percentages for the no PB or RB group are based on the data available because there were missing data for ChEDE-Q variables as follows in the no PB or RB group: *n*=8 vomiting, *n*=3 laxative/diuretics, *n*=3 binge-eating.